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ENDOUROLOGY

Original Article

The effect of ureteroscope size in the treatment of ureteral stone: 15-year experience of an endoscopist

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ABSTRACT

Objective: We aimed to investigate the ureter stone treatment results performed by using different- caliber semirigid ureteroscopes (URS).

Material and methods: Adult patients who were treated for ureteral stones by a single endoscopist between January 2000 and March 2015 were analyzed. The patients were divided into 3 groups in accordance with the caliber of the ureteroscope used: 10/10.5 F Storz (Karl Storz, Tuttlingen, Germany) (January 2002-January 2005) URS was used in group 1, 8.9/9.8 F Storz (February 2005-December 2011) URS was used in group 2, and 6/7.5 FWolf (Richard Wolf, Knittlingen, Germany) (January 2012-March 2015) URS was used in group 3. Patients' age and gender, size and site of stones, stone-free rates (SFR), intra- and perioperative complication rates, and durations of surgery were compared among the groups. Intraoperative complications were classified according to modified Satava, and perioperative complications were classified according to modified Clavien classification systems.

Results: A total of 2461 patients treated for ureteral stones were analyzed. There were 583 patients in group 1 (10/10.5 F Storz), 1302 patients in group 2 (8.9/9.8 F Storz), and 576 patients in group 3 (6/7.5 F Wolf). SFR were 83.7%, 87.4%, and 92.2% in groups 1, 2, and 3, respectively (p=0.01). Duration of surgery was 30.34±10.36 min in group 1, 31.61±10.10 min in group 2, and 42.40±7.35 min in group 3 (p=0.01). The overall complication rates classified according to modified Satava classification were 10.8%, 7.6%, and 6.9% (p=0.01) while grade 3 modified Satava complication rates were 1.9%, 1.5%and 0.5% in groups 1, 2, and 3, respectively (p=0.01).

Conclusion: In this study, we found that more frequent use of a small- caliber URS resulted in a longer duration of surgery and an increased rate for JJ stent insertion, however it facilitated a safer and more successful ureteroscopy procedure.

Keywords: Complication; ureteral stones; ureteroscopy.

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Introduction

Ureteroscopy is the most frequently performed procedure worldwide by urologists. This procedure was first performed by Young,[1] in 1902 in a patient with a proximal ureter stone; however it was popularized in the field of urology in 1960s following advances in Dr. Hopkins rod- lens optical systems,[2] and Karl-Storz fiberoptic cables and cold light sources. Innovations in the last two decades enabled miniaturization of endoscopic equipment. Thus, urologists had the opportunity of using and experiencing ureteroscopes (URS) with different calibres. All those technological advances have some advantages and disadvantages.

Use of small-calibre URS has the advantage of facilitating better intraluminal mobility and a better rate to reach the stones, however smaller vision of the surgical field and fewer numbers of working channels are their disadvantages.

Although a number of studies in the literature compared success and complication rates of different- calibre endoscopes in treatment ureteral stones in children and adults, lack of consensus and small numbers of the patients included are noteworthy.[3-7]

In this study, we aimed to compare stone- free rate (SFR), duration of surgery, and complication rates in a large series performed by a single endoscopist by using different- calibre URS.

Material and methods

Study population

The study was performed under the ethical principles of the Declaration of Helsinki, and approved by the local Ethics Committee of the Ankara Training and Research Hospital. All patients provided their informed consents concerning the risks of the procedure. The data of consecutive patients treated for a single ureteral stone between January 2000 and March 2015 were retrospectively analysed. The patients treated with 10/10.5 F Storz (group 1, n=583, between January 2000 and January 2005), 8.9/9.8 F Storz (group 2, n=1302, between February 2005 and December 2010) and 6/7.5 F Wolf (group 3, n=576, between January 2010 and March 2015) endoscopes were included in the study. The patients with multiple ureteral stones, ureteral strictures, active urinary tract infection, previous URS or shock wave lithotripsy, ureteral re-implantation surgery, ureteral stent placement, laparoscopy, or open surgical ureterolithotomy and pediatric patients under 18 years old were excluded. All patients had kidney function tests, urinalysis, urine culture (when needed), kidney-ureter-bladder (KUB) radiography, computerized tomography or intravenous urography and ultrasonography before surgery.

Ureteroscopy technique

Ureteroscopy procedures were performed in lithotomy position, under spinal or general anaesthesia, using a 10/10.5 F Storz, 8.9/9.8 F Storz or 6/ 7.5 F Wolf semirigid URS with a holmium laser or pneumatic lithotripter, in all patients. The safety guide wire (0.035 inch) was placed into the ureteral orifice through the URS, and under the guidance of the catheter, the URS was introduced directly into the ureter up to the level of the stone. The ureteral orifice was dilated with active or passive dilatation, and auxiliary equipments were used as needed in order to prevent upward migration of the stone into the renal pelvis. Large fragments were removed using a stone basket. Following complete removal of the stone, entire ureter was examined by URS to determine presence of any residual stones and/or mucosal injuries. When necessary, a JJ stent was placed postoperatively to avoid ureteral damage. Use of a JJ stent was decided based on the duration of the procedure, and the degree of visible ureteral trauma or edema at the end of the procedure. All procedures were performed by one endocscopist (A.D.), or under his guidance and companion. Intra- and postoperative complications were graded according to modified Satava,[8] and Clavien[9] systems, respectively. The JJ stent was removed 2 - 6 weeks after the procedure.

Kidney-ureter-bladder radiography was performed on postoperative day 1 to exclude the presence of residual stones. Stone-free status was examined at postoperative week 4, and defined as radiologic absence of stone, or asymptomatic patient in presence of stone fragments <4 mm in size, which is called as "insignificant residual stones".

Statistical analysis

The data were analysed using Statistical Package for the Social Sciences for Windows, version 11.5 (SPSS Inc; Chicago, IL, USA). The normality of distribution was tested with P-P plot and Kolmogorov-Smirnov tests. One-Way ANOVA variance analysis was used for intergroup comparisons of continuous variables (Post hoc: Bonferroni). Chi square test was used for comparison of categorical variables. Descriptive statistics of the variables that were not distributed normally were presented as median (min-max), and the nominal variables were presented as the number and percent of the cases. $P<0.05$ was regarded as statistically significant.

Results

There were 583 patients in group 1, 1302 patients in group 2, and 576 patients in group 3. SFR's in groups 1, 2, and 3 were 83.7%, 87.4% and 92.2%, respectively (p=0.01). The mean operation time and JJ stent placement rate were higher in group 3, and the differences among the groups were statistically significant (p=0.01). There were no significant differences among three groups for gender, age, stone size or location (Table 1).

Intraoperative complications were graded according to modified Satava classification system, and perioperative complications were graded according to modified Clavien classification system (Table 2). The procedures were converted to open surgery in 11 (1.9%) patients in group 1, 20 (1.5%) patients in group 2, and in 3 (0.5%) patients in group 3 due to inability to reach the stone, impacted stones, severe ureteral stricture, tortuous, kinked, or angulated ureter, ureteral perforation or avulsion, or technical problems. The overall complication rate was higher in group 1 compared to groups 2 and 3 (10.8% vs. 7.6% and 6.9%, respectively) (p=0.01). The majority of the intraoperative complications were modified Satava grades I or II. Thirty- four (0.1%) patients had grade III injuries, and only 3 of them were in group 3. Urinary tract infection was the most frequent postoperative complication (28%). Only one patient had Modified Clavien grade IV injury (sepsis, multiorgan dysfunction and death), and he was in group 1 (p=0.3).

Discussion

Endourology is a technology-dependent field, and recent technological advances caused a global popularization of endourological procedures. Upon launching of new- technology devices, it was emphasized that procedures performed with new and smaller- calibre instruments would be more successful and cause less injury, and this caused high expectations in the surgeons. Do we really know whether those expectations have been met?

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Table 1. Patient characteristics

	Group I (10/10.5 F Storz)	Grup II (8.9/9.8 F Storz)	Grup III (6/7.5 F Wolf)	p
No. patients	583	1302	576	
Age (mean)	44.44±14.6	43.10±15.6	42.7±15.13	0.126
Sex				0.2
Men	349 (59.9%)	864 (66.4%)	378 (65.6%)	
women	234 (40.1%)	438 (33.6%)	198 (34.4%)	
Stone size (mm)	10.26±4.06	10.08±3.7	10.12±2.67	0.632
Side				0.31
Right	250 (42.9%)	610 (46.9%)	271 (47%)	
Left	333 (57.1%)	692 (53.1%)	305 (53%)	
Location				0.41
Distal	439 (75.3%)	763 (58.6%)	335 (58.2%)	
Middle	72 (12.3%)	409 (31.4%)	167 (29%)	
Proximal	72 (12.3%)	130 (10%)	74 (12.8%)	
Stone-free Rate	488 (83.7%)	1138 (87.4%)	531 (92.2%)	0.01
Complications	63 (10.8%)	99 (7.6%)	40 (6.9%)	0.01
Operation time (min)	30.34±10.36	31.61±10.10	42.40±7.35	0.01
Double-J stent placement	66 (11.3%)	215 (16.5%)	143 (24.8%)	0.01
Lithotriptor type	583	1302	576	0.07
Pneumotic	491 (84.3%)	937 (72%)	173 (30%)	
Laser	92 (15.7%)	365 (28%)	403 (70%)	

Ureteroscopy for ureteral stone treatment is the most frequently performed endourological procedure worldwide by urologists. In the last two decades, small- calibre instruments (rigid-semi-rigid-flexible) provided better intraluminal mobility. Smaller calibre lithotripters (ultrasonic- laser fiber) used through narrower channels of small- calibre URS may enable a more effective lithotripsy.[10,11]

European Association of Urology/American Urological Association Collaborative Guidelines Project Updates reported that SFR varied between 79% and 97% in relation with the stone location in URS used for treating ureteral calculi.[10] A number of studies investigated the effect of URS calibre on success rate in children and adults. Investigations on adults reported success rates of small- calibre URS between 84-89.8% while reported success rates of large- calibre URS were between 80-85.5%.[3,4,7] Atis et al.[7] compared results of 4.5F semirigid URS and 8.5F rigid URS, and reported the success rates as 88.5% and 84.6%, respectively. The results of that study indicated that there was no statistically significant difference between success rates of small-and large-calibre URS. In children, the success rates of small- calibre URS varied between 90.7-97.4% while those rates were 78.6-87.8% with large- calibre URS.[5,6] Atar et al.[6] compared the success rates of 4.5F semirigid URS and 7.5F rigid URS in 69 preschool children, and found them as 92.6% in 4.5 F semirigid URS group, and as 78.6% in 7.5F rigid URS group.

In our study, SFR in 10/10.5 F, 8.9/9.8 F and 6/7.5 F groups were 83.7%, 87.4% and 92.2%, respectively. Those results are in accordance with the studies in the literature. We suppose that high success rate of small-calibre URS may be due to easier and safer access to ureteral stones with this instrument.

It becomes evident that URS has a high complication potential although it is a quite effective in treatment of ureteral stones. The overall complication rate after URS was reported as 9-25% in the literature.[12,13] Hong et al.[14] reported that use of small-calibre equipment reduced complications and morbidity related to URS significantly. A study that compared different- calibre URS reported the complication rates of small- calibre URS as 1.2-13.1%. Those rates were reported to be significantly smaller when compared to large- calibre URS.[3-7,15] Francesca et al.[3]

Table 2. Intra-and perioperative complications

	Group I	Group II	Group III	p
No. complications	63 (10.8%)	99 (7.6%)	40 (6.9%)	0.01
Intraoperative complications				
Satava I (Observation)	37	45	29	0.03
Mucosal tears	20	31	25	
Mild bleeding	8	9	3	
Malfunction or breakage of instruments	5	3	3	
Proximal stone migration requiring observation	4	2	1	
Satava II (requiring endoscopic retreatment)	13	27	7	0.01
Proximal stone migration treated with endoscopic surgery in the same session	4	9	4	
Mucosal injury (false route or thermal injury) requiring secondary ureteroscopy	3	6	1	
Inability to reach stone requiring secondary ureteroscopy	3	5	1	
Ureteral perforation requiring nephrostomy insertion and secondary ureteroscopy	1	3	1	
Severely bleeding termination of the procedure and secondary ureteroscopy	2	4	0	
Satava III (requiring open surgery)	11	20	3	0.01
Inability to access ureter or reach stone requiring conversion to open surgery	6	11	2	
Ureteral perforation	3	5	1	
Ureteral avulsion	2	3	0	
Perioperative complications				
Clavien I				0.74
Fever	7	7	4	
Hematuria	4	15	1	
Clavien II				0.6
Urinary tract infection	19	28	11	
Clavien III				0.08
Renal Colic	3	9	5	
Stone migration	5	12	5	
Clavien IV				0.2
Sepsis	2	1	1	
Clavien V				0.3
Death	1	0	0	

reported significantly less ureteral perforation risk with small-calibre URS (1.2% vs. 12%).

In our study, the overall complication rate was higher in group 1 when compared to groups 2 and 3 (10.8% vs. 7.6% and 6.9%, respectively). Those results are in accordance with the literature. Intraluminal advancement is easier, and there is less need for balloon dilatation with use of small- calibre URS, and those factors decrease the risk for mucosal damage and ureteral perforation risk.

There is also a debate on use of ureteral stents after URS. Although several randomized prospective trials showed that use of JJ stents after uncomplicated URS was unnecessary and

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carried a higher postoperative morbidity, many urologists use JJ stents routinely after URS.[16-18] Studies comparing URS sizes in children reported a higher JJ stent insertion rate after small-calibre URS.[5,6,15] In adult patients, Yaycıoğlu et al.[4] reported higher stenting rates after small- calibre ureteroscopy, however Atis et al.[7] emphasized a reduction in postoperative rate of stent use. Kocaoğlu et al.[15] reported use of stents in 42% of the patients after small-calibre URS in children.

In our study, postoperative stenting rate was 11.3% in group 1, 16.5% in group 2, and 24.8% in group 3. We observed that postoperative stenting rate increased as the calibre of URS decreased. We suppose that the morbidity that might occur due to edema and leaving small stone fragments for spontaneous passage after stone fragmentation with smaller- calibre URS increase rate of postoperative stenting.

A number of factors may affect duration of URS, and technical factors including need for using auxiliary equipment, duration of fragmentation, clarity of vision, and speed of irrigation flow constitute the majority of them. Use of small- calibre URS has been studied only in a few studies without any consensus in their results.[4,6,7]

Yaycıoğlu et al.[4] reported that duration of surgery was 57±35 min in small-calibre URS group, and 54±30 min in large-calibre URS group. Atis et al.[7] found those durations as 32.7±5.8 and 30.2±5.4 min in small- calibre and large- calibre URS, respectively. In children, Atar et al.[6] reported duration of surgery as 53 min in 7.5 F URS group, and 46.5 min in 4.5 F group.

The technical specifications of the URS used in our study were as follows: 6/7.5 F ureteroscope; straight ocular and 1 working channel (4.2 x 4.6 F), 8.9/9.8 F ureteroscope; 45°offset and 2 working channels (5 x 4.2/3.2 x 3.4 F), 10/11.5 F ureteroscope; 45° ocular and 3 working channels (5.5/3.0/2.0 F). Taking those specifications into consideration, we suppose that small-calibre URS minimized the need for ureteral orifice dilation, however less clear vision of the operative field, slower flow of the irrigation fluid due to narrower working channels, and an obligation to use smaller calibre laser or lithotripter cause a longer duration of surgery.

Although performing all procedures by a single endoscopist for a long period seems to be bias for favourable to study outcomes, there is a point to be clarified: Is there any association between increased stone free rate and decreased complication rate with smaller calibre ureteroscope and gained more experience of endoscopist during 15 years? According to a meta-analysis study,[19] which was investigated learning curve of URS, to increase stone-free rate and reduce severe complications, it was necessary for the surgeon to have performed more than 50 cases in a high-volume center. Therefore, the center which was conducted the current study has a high-volume center for the treatment of ureteral stones since 1990s and an endoscopist had gained surgical competence for this procedure at the beginning of the study.

There are some limitations of the study. Our study had a retrospective design. Retrospective studies may be a potential source of selection bias. Our study also includes bias concerning the type of lithotripter, which might affect the outcomes; however there is no statistical significant difference among the groups. We did not perform stone analysis or determine their density although those are predictor factors that affect success rate of the procedure. Despite those limitations, collecting and recording intra- and postoperative findings and follow-up results in all our cases are important for grading complications and determining the success rate. The numbers of patients in our study groups are relatively greater compared to previous studies in the literature.

In conclusion, technological advances in the last decade enabled miniaturization of the endoscopic instruments. Higher SFR could be obtained by using smaller calibre instruments in adult ureteral stone disease together with a smaller complication rate. However, duration of surgery and use of JJ stents were observed to increase.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Ankara Training and Research Hospital.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - M.F.K., Ö.G.D.; Design – T.K.; Supervision - B.R., A.D.; Resources - N.C.S., C.N.Y.; Materials - N.C.S.; Data Collection and/or Processing - T.K., C.N.Y.; Analysis and/or Interpretation - M.F.K.; Literature Search - Ö.G.D.; Writing Manuscript - M.F.K.; Critical Review -B.R., A.D.

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